XXXII.—*The Vegetable Individual, in its relation to Species.* By Dr. ALEXANDER BRAUN, Professor of Botany in the University of Berlin, &c.* Translated by CHAS. FRANCIS STONE.

[Continued from p. 256.]

PART II.

As I attempted to show in Part I., whatever seems arbitrary and indefinite in the existing views of what constitutes the Vegetable Individual has its ground in the nature of plants themselves, which in their realization are resolved into a plurality which they are not capable of reducing to as complete a unity as animals are. As we ascend in the natural kingdoms, individuals increase in importance, until they reach their most perfect independence in Man. Hence, if we would appreciate them justly in the lower departments, in which their character is less definite, we must try to comprehend the less perfect structures by starting from the more perfect ones: to appreciate vegetable individuals we must start from a comparison of animal individuals. From this point of view we perceive at once that the cell cannot be regarded as the proper individual in plants, otherwise it would have to be considered in the same manner in animals. Cell-formation is a property common to plants and animals: but in animals it appears far more obviously as a subordinate element in the organization of the whole body, than it does in plants; since the animal cell, in most cases, is not so independent, nor so determinate, nor so permanently isolated as the vegetable cell. For this reason, too, it is rarer to find the animal cell considered as the proper animal individual, although Schwann has shown that animal cells are analogous to vegetable cells, and may be as justly considered individual organisms as they. Yet as mere *curiosa* we might adduce the somewhat similar assertion of Gaillon, that "men and animals are properly masses of Infusoria;" and Oken's doctrine of generation, "a synthesis of Infusoria," might, perhaps, be interpreted in the same sense. The "stories" of the axes, the internodes with their leaves, might claim to be compared with the animal individual with more justice than the cell, especially if leaf-formation really took place, as the defenders of such doctrines have represented; that is, if every successive leaf were produced as a *new* structure out of the old one (out of its base which becomes the internode), and if the whole stem were thus merely a concatenation of leaves shooting out of and growing above each other. But this is not so: the rudiment of the stem as an uninterrupted growth ("conti-

* Reprinted from Silliman's American Journal for September 1855.

nuance") is formed *before* the leaves, while the latter, emerging as developments of the upper surface of the stem, are evidently members dependent upon and belonging to the axis, and forming with it one whole. Hence the structure of the internodes may be more aptly compared with the lateral structure of the animal body, and that of the leaves with its terminal structure. Thus we arrive at the shoot; and we must investigate the question, whether it should be considered as what corresponds best with the animal individual, or whether we must ascend still farther, up to the whole plant-stock.

The Shoot as the Vegetable Individual.

The first and most common view is that which considers the individual in plants, as in animals, to be merely each single specimen, *i. e.* each representative of the species which appears to be one whole from the connexion of its parts. To some extent this view is correct, for in a forest of trees of the same genus and species, in a meadow, or in a corn-field, each single tree, each stock of grass or of grain, appears as a single member of its species, as each single beast does in a flock of animals forming a community. But the question arises whether these individual beings, regarded as such in this superficial way, can each be considered individuals in the same sense. When the flocks or societies of animals are numerous, as in an apiary, each hive or swarm will appear as an individual member of its species, and the more so in proportion to the closeness of the connexion between the members of such a community. Many flocks of animals whose members are organically connected during life, have until lately been considered to be individual animals; and even when the separation of the individuals is more complete, such conceptions are to a certain extent justified as long as the community is really a natural growth—when in fact it consists of members of one single stock—and we are not surprised to find that the oldest history of the human race describes the family itself, and the tribe which springs from it, as one person, named after its patriarch. As regards the plant-stock, even a superficial examination shows us peculiarities which will hardly allow us to consider it as an individual in the precise meaning of the term, and which calls upon us carefully to consider whether it is to be regarded as such an individual, or merely as an individual in the broader sense,—as one united family. Even our feelings aroused by the sight of the most ramified plant-stocks,—especially by a tree with its numerous branches, with the thousands of blossoms and fruits which it bears, and the numberless buds through which it will deck itself again in the following year with leaves and flowers—excite the presentiment that this is not one single being, one single life, comparable with the animal or the human individual, but rather a world of united individuals which have sprung from each other in a succession of generations, and although they do not separate, going through their particular cycles of existence,—here dying off, there reproduced, and thus building themselves up in uninterrupted succession into a family-tree, perennially laden with an increasing posterity. That such a view, so consistent with our healthy natural feelings, is corroborated by scientific investigation, I hope to show in the following observations.

Comparing plants with animal individuals, it is at once evident that the tree loses annually flowers and fruit,—the highest and noblest structures which vegetable life produces,—to generate them again in the following period of vegetation. Even the whole dress of the tree, even its foliage when compared with the trunk and branches, is only a superficial growth periodically dying off, and reproduced by the succeeding generation: in the paradoxical words of Schleiden *, "No tree has leaves." The leaves, in fact, never grow out of the woody portions of the tree, but only on its herbaceous extremities, which grow upon the woody stem as upon a ground formed by the process of vegetation. This common ground, namely the woody stem, which is almost lifeless in comparison with the herbaceous parts engaged in active growth, is annually covered with a vigorous sheath under the protecting bark, and this sheath is the ground of the nourishment of all the vegetating herbaceous extremities. This sheath is the so-called *cambium*, a layer of active, living tissue, which, contemporaneously with the lignification of the herbaceous extremities of the branches, becomes a new woody layer, united to the old trunk in the form of an annual ring—to be covered in its turn in the following period of vegetation with a new layer, which, again, will be the immediate supporter of the new generations. The history of the grand development of nature on the surface of our globe presents an analogy which may perhaps serve to set this relation in a clearer light. The successive geological formations superposed during the course of countless ages, present, buried in their depths, the traces of as many formations of the organic world, each of which carpeted the then superior stratum of the earth with a new life, until it found its own grave in the succeeding formation, when a new

* Beitr., p. 152, where the following view of the arboraceous stem, as a common ground bearing many individuals, is developed; but this whole view, after all, needs to be corrected by a precise limitation of its meaning by what follows it.

uprising of organic life took its place. In the same way the stem of a tree is a multistratified ground, in whose layers the history of earlier growths is legibly preserved. The number of the woody layers indicates the number of the generations which have perished, *i. e.* the age of the whole tree: a distinct annual ring is the monument of a vigorous season, an indistinct one of a bad season, a sickly one (which is often found among healthy ones) indicates the unhealthiness of the foliage of that particular year. The practised woodman can decipher many facts of the past in the layers of the trunk, *e. g.* a good season for foliage or for seed, damage by frost or by insects, &c.

Essentially the same relations as those seen in the tree, or the shrub, are to be found in the subterranean perennial growth of *plantæ redivivæ* (herbaceous perennials), whose subterranean stem (rhizoma), like the stem above the surface, emits annually a new generation of herbaceous growths; whose stalks however, unlike those of the tree, do not lignify and form a part of the common supporter, but die off wholly, or mostly, at the close of the season of vegetation.

The relations indicated above compel us to recognize a succession of generations in trees, shrubs, and perennial herbs; and thus our first idea of them as individuals is necessarily modified. Another remark may be made here which confirms our idea thus modified. Natural *death* closes the life of the individual*. The development of the life of individuals in organic nature has a goal, an acme; after it has attained this goal its course draws to an end. This is not the case in the tree and the perennial herb. True, the tree is destroyed by time; but this seems to result more from external, and in part mechanical causes, than from any internal decrepitude. The more numerous the generations which the tree builds up, one above the other, the greater is the distance of the growing extremities from the source of their nourishment: the thicker the supporting trunk, the thinner is the layer of cambium which connects the new shoots with the extremities of the root by which the nourishment is absorbed. This increased

* Cf. Schleiden, Beitr. p. 151. "The idea of individual life necessarily implies as its distinguishing characteristic individual death, preconditioned in the organization itself." Although this remark is not universally true in many respects, yet I have adopted it for the light it is calculated to throw on the nature of the tree. For the very reason that natural death is the result of a determinate conclusion of the development, those shoots (vegetable individuals) which have no such conclusion frequently undergo no death at all except that of some of their parts: but this is a concomitant of animal life itself (casting the skin, moulting, and the organic changes in the body). Cf. on this point Roeper, Linnæa, 1826, p. 439, and the following remarks on *Paris, Lysimachia nummularia, Adoxa,* &c., and the preceding ones on *Caulerpa.*

difficulty of communication between the upper and lower extremities is probably the cause of the decrease of vigorous growth after the plant has arrived at a certain age. But in most cases external casualties are superinduced, which accelerate the termination of the tree's life. It is injured by wind and weather, the decay of the injured part spreads through the whole organism, various fungi fix themselves upon the tree, and are especially fatal when they attack the roots. Oftentimes the tree breaks down under the weight of the productions of its own vital powers, the luxuriance of its fruit. These statements are corroborated by the cases of trees of unusual age, now so well known through DeCandolle's investigations. One of the examples adduced by him shows in particular, that those trees whose branches have been prevented from breaking down by props or supports attain to a great age. I refer to the celebrated Linden in Neustadt on the Kocher, which, as early as 1229, was the cause of the town being called "Neustadt an der grossen Linde" (Neustadt of the great Linden), whose wide-spreading branches were supported already in 1408 by sixty-seven stone pillars, and this number was afterwards increased up to more than one hundred*. The hoary tree still flourishes, having survived its many scientific admirers, among whom was my predecessor, to whom botany is so greatly indebted, who visited and described it a few years ago (in 1849†). Natural supports are more efficacious in preserving trees than even artificial ones; since they not only prop the branches, but conduct nourishment to them by a shorter road, as is actually found to be the case in *Rhizophora Mangle*, in various species of figs [Banyan, &c.], and other tropical trees, whose branches high in air send down strong roots into the earth. A similar example nearer home, though indeed on a much smaller scale, is found in the *Juniperus Sabina*. Its branches, which spring from a low stem, curve down to the earth, strike numerous roots, and raise themselves again, so that the comparatively feeble stem may carry a creeping crown of considerable extent, like a thick wood continually spreading, and which may continue to flourish in its parts, even when the communication between the original supporter and nourisher of the whole colony and the succeeding new growths, which are constantly receding from it, has finally ceased. A remarkable specimen of this tree stands in the Royal Botanical Garden at Schöneberg, which, if not as old as the garden itself, which was laid out in 1679 under the great Elector, Frederic William, cer-

* DeCandolle, Physiol. Veg. ii. p. 988.

† Link, Erinnerungen an die grosse Linde bei Neustadt am Kocher (Flora, 1850, no. 8).

tainly dates as far back as Gleditsch's time, and his directorship commenced in 1744. The main stem is not more than 33 inches in circumference at eight inches above the ground, close under the place where the first branches originate: the centre-piece of the crown which belongs immediately to the stem is only 9 feet high, and has been dying off during several years, while the maximum diameter, from S.W. to N.E., of the hundred-rooted crown, which has spread out over the ground by the declination of the branches, measures 35 feet: the entire circumference of the crown, which amounts to about 100 feet, would be still more considerable if it had been permitted to spread on every side, and if the branches on the N.E. side had not been removed at an early day.

What has just been said of trees admits of no doubt as regards perennial herbs (*plantæ redivivæ*) with subterranean creeping stems or stolons. Such plant-stocks as those of the well-known *Paris, Anemone nemorosa, Convallaria majalis, Asperula odorata,* are undoubtedly exposed to none but a casual death *. All plants which renew the cycle of vegetative life repeatedly and without any determinate limits to their existence, and which I would hence call *anabiotic,* cannot therefore be considered *simple* individuals †.

At first sight the case seems to be different in the *haplobiotic* ‡

* The same relations of great unlimited age are found in polyps which form stocks. Cf. Ehrenberg, Abh. d. Akad. for 1832, p. 382, 420, where, among others, stocks of Mæandriæ and Faviæ are referred to, larger than a cord of wood—which may readily be supposed to have been seen by Pharaoh.

† I pass over the further question, intimately connected with this subject, whether the composite plant-stock itself, with all its subordinate generations, with all its possible divisions,—viz. the individual in the most comprehensive sense (in which Gallesio conceived it),—has not a determinate term of life, though not easy to be ascertained, on account of the narrow space of time accessible to our direct experience.

‡ DeCandolle calls *anabiotic* growths *polycarpic,* and *haplobiotic* growths *monocarpic,* terms which are useless from their ambiguity. With an equally inappropriate choice of terms, he divides the first (Phys. Veg. ii. p. 73) into *caulocarpic* and *rhizocarpic,* according as the stem which produces the fruit is permanent, or dies off down to the root; but the latter in fact never takes place in perennial growths; for in such cases the life of the plant-stock is preserved, not by the mere root alone, but by a subterranean portion of the stem. It is one of the most remarkable confusions which a want of true biological ideas has engendered, that DeCandolle should have regarded the simplest and most natural circumstance in the plant's life,—its death after having attained the goal of its development,—as an unnatural, and to some extent casual occurrence,—as a kind of sickness comparable to the succumbing of the mother in childbed, which he accounts for by the rapaciousness of the flowers and seeds. Roeper, however, in a note to his translation of the above work, justly remarks that there are annuals with double flowers which die off to the ground although they

plants, which terminate their existence at the end of the simple process of development, with the formation of flowers and fruit; and this they do whether they exist one year, as *Adonis æstivalis* and *autumnalis, Nigella, Papaver Rhœas, Erigeron Canadensis**, or for two years, as *Œnothera* and *Verbascum,* or for many years†, as *Agave* (Century-plant), the East Indian *Corypha,* and the Mexican *Fourcroya*‡, which suddenly puts forth its flowers only after 400 years of extremely slow growth, and ends its life with the formation of its first and long-deferred fruit. The development of these plants, when compared with that of the first-mentioned anabiotic plants, seems at first to comprise only *one* generation, and to depend upon the development of *one* individual. But here, too, a closer examination shows conditions incompatible with the nature of the simple plant (the individual). One constituent element in the idea of an individual is, that the parts of the organism are *essentially* connected; yet the stock of annuals themselves presents a multitude of parts which bear no essential relation to the whole plant. This is true of a large part of the ramifications, of branches which may exist in one case and not in others, and which are proved to be unessential by the plant's losing no essential function when deprived of them. For even when the plant does not produce them, it can fully consummate the object of its individual life: it can produce flowers and fruit. A glance at the examples just now adduced, *Nigella, Papaver Rhœas, Adonis,* &c., will make these statements obvious. The branches of these plants, each of which, like the stem, is crowned with flowers and fruit, are evidently only *unessential repetitions of the simple plant,* absolutely identical with the main stem, and

produce no seeds. We may convince ourselves beyond a doubt that the flowers, on the contrary, are much less rapacious than the vegetative parts of the plant,—that they even shut themselves off from the afflux of too copious nourishment; for many plants develope vegetative branches close under the terminal flower, as *e. g. Stellaria media, Datura, Mirabilis,* &c. In such cases the flower-stalk, which cuts itself off from almost all farther afflux of nourishment, remains slender, while the portions of the stem directly beneath, and the branches which spring from it, gorged with succulent matter, enlarge more and more, and attain a most disproportionate size.

* These plants, like other annuals which germinate in the autumn, are usually reckoned among biennials; but this is a mistake, for, like our winter corn, they are *plantæ annuæ hiemales.* So, too, many vernal plants, as *Teesdalia, Erophila, Cardamine hirsuta, Spergula Morisonii,* and many weeds of the winter corn, *e. g.* several species of tares, *Bromus secalinus et aff.*

† *Corypha umbraculifera.* Cf. Rheede, Hort. Mal. iii. pl. 1–12. This is also the case in the palm genera *Metroxylon* and *Eugeissona,* according to Martius (Hist. Palm. i. p. 108).

‡ On *Fourcroya longæva,* cf. Zuccarini in the Nov. Act. Nat. Cur. xvi. 2. p. 666, and pl. 48.

hence to be ranked as equal to it in importance, *i. e.* equally to be viewed as particular individuals, and with as much reason as in zoology we concede individuality to the branches of the coral-stock (polypidom), which are now universally acknowledged to be individuals, and which offer an analogy of decisive importance for ascertaining the nature of the branch in vegetables. In view of this analogy, Ehrenberg regarded plants as aggregations of individuals*.

We can now turn back, and apply what has been shown to be the case in the annual herb, to the shrub and the tree, each of whose annual generations now appears, more distinctly than before, to be, in their peculiar connexion, not one individual, but a world of individuals developing in the same period of vegetation and upon the same stem. To this intent many of the early botanists have expressed themselves, as I stated in the introduction. Thus, B. Batsch, *e. g.*, says of branches, that they shoot forth from the stem "as if they were so many plants rooted in it†;" and Goethe‡: "Lateral branches may be regarded as particular plantlets which are rooted upon the maternal stem, just as this stem is upon the earth." Among moderns, Unger, at the close of his investigations into dicotyledonous stems, says, ". . . . Buds and the branches they develope are individual plants, which live by preying upon the maternal stem§." Similar expressions are used by Schleiden ||; they are most definite in

* Abh. d. Akad. 1835, p. 247. ". . . . Hence a polyp-stock is a mass of animals. We have no satisfactory comprehensive expression for our idea of a plant. What an individual is, remains still unknown; most of them are evidently aggregates of individuals which may be compared with coral-stocks." The origin of coral-stocks is minutely described by Ehrenberg in the Abhandl. for 1832, where he makes the following remarks:—"The coral structure is neither a mere structure composed of many animals arbitrarily conjoined, as Ellis supposed; nor one single animal with many heads, or with simple furcations, as Cavolini maintained; nor a vegetable stem with animal flowers, as Linnæus expressed it; it is a body of families, a *living* tree of consanguinity; the single animals belonging to it, and continually developing upon the primary ancestor, are entirely isolated within themselves, and capable of complete independence, although unable to achieve it."

† Bot. für Frauenzimmer, pp. 15, 16.

‡ Versuch d. Metam. d. Pfl. zu erklären, p. 59. The words "just as" in the passage quoted imply too much, and remind us of Du Petit-Thouars' unfounded doctrine of the formation of the woody layers of the stem by the 'roots' of the buds which penetrate it.

§ Ueber d. Bau u. Wachsthum des Dicotyledonenstammes, p. 177. Here, too, "preying" is too strong a term.

|| Grundz. ii. p. 4. "New identical individuals develope upon the maternal stem by continuing the growth," &c. Here the expression "continuing the growth" is improper, for the shoot does not "continue" the growth at all, but is a new growth from a new rudiment.

Roeper's works*. Linnæus expressed the same thought in the words "*gemmæ totidem herbæ.*" And I am thus led to make a particular remark, which is intended at the same time to modify in some degree what I said before in relation to the annually renewed generations of trees. It is indeed true that branches of trees and perennial herbs, especially in temperate climates, first appear as buds; and in a more extended sense we call in general every young branch a bud, even if its parts are not, as they usually are, compactly arranged and folded together; still, all buds are not the rudiments of branches. *Lateral* buds are the only ones from which branches originate, and therefore they alone are to be regarded as new lines of development,—as individuals. Terminal buds, on the contrary, are nothing but still-undeveloped parts of the (relative) principal axis: they are mere continuations and augmentations of the individual already existing, and are not to be regarded as commencements of a new one†. Hence, only those trees which produce no terminal buds, as the Linden, Willow and Elm, develope new individuals and nothing else at each renewal of vegetation; while, on the contrary, those which do produce terminal buds also, as for example the Oak and Poplar, bear a mixed annual generation, which consists partly of new individuals, partly of old ones reawakening and continuing their development with renewed vigour.

I have already remarked how unessential the presence of branches is in many plants. A comparison of stocks grown on a rich soil with those of a poor one shows what license is given to plants in regard to producing branches, and how different the appearance of specimens of the same species thus becomes. Plants grown on a poor soil are often called dwarfs; but

* "Omnis gemma solitaria aut ejusdem continuatio immediata et perpendicularis (caulis, ramus, ramulus, flos) individuum vegetabile vocatur." This is the most definite description I know of; for in this passage not only the branches so called, but also every arbitrary shoot, even when it is merely a flower, is acknowledged to be a particular individual. Besides what I have stated in the text in regard to the appearance of terminal buds, I have only to remark, against the word "gemma," that in its growth every shoot does not enjoy a perceptible state of gemmation, *i. e.* a state of rest in which its parts are folded together. The term 'bud' is applicable to but one state of a shoot or of its parts, and therefore cannot be a suitable expression for what is to be regarded as the vegetable individual.

† Kützing (Phil. Bot. ii. p. 146) aptly expresses these relations by calling the terminal bud the continuation of the "series of formations;" lateral buds, beginnings of a new "series of generations." In contradiction with these terms, however, he calls the bud an "organ" as long as it is connected with the natural individual,—a term inapplicable to the bud as it is to the developed branch, of which it is the adolescent state.

unjustly, for they present the most normal development of all essential parts, dispensing with everything that is unessential, and are much less inclined to malformations than the lusty giants of the rich soils. Not unfrequently we find diminutive specimens of *Erythræa pulchella s. ramosissima* which are branchless and perfectly simple, as they terminate with a flower after four or five pairs of leaves. More vigorous specimens produce two branches out of the axils of the highest pair of leaves, which after a single pair of leaves terminate in the same manner with a flower; and branches of the second order may be also emitted from the axils of the two leaves preceding this flower; and so on. In the first order of ramification the number of flowers amounts to three, in the second to seven, and so on; in the seventh, which is not unfrequently attained, it amounts to 127! Here, if we would consider the stock or specimen as the individual, and the flower as the superior termination of the vegetable organism, comparable, say, to the head of the animal, this variation in the number of the flowers would be as astounding as if we were to learn that an animal might have 3, 7, 15, 31, 73, or 127 heads, according to circumstances. The same thing occurs in *Radiola linoides*. *Erigeron Canadensis*, which often grows to the height of a man and bears as many branches as a tree, presents dwarfed specimens scarcely two inches high and of a perfectly simple form*. After developing two early deciduous cotyledons it presents about 13 leaves on the stem, which are followed by a terminal capitulum of 21 involucral bracts and about 34 flowers. One middle-sized specimen about three feet high presented nearly 100 branches of the first order, out of which branches of the succeeding orders proceeded, together bearing about 2000 heads, and hence (reckoning the head at 34 flowers) 68,000 flowers†.

I may here remark, that such unessential branches may be separated and reared independent of their parent stem; on which fact depends propagation by artificial divisions, which is so variously employed in horticulture. The most remarkable case of this artificial division is recorded by Miller: in the year 1766–67, he obtained 500 stocks of winter rye, by dividing one stock and repeating the operation three times; these 500 stocks emitted 21,109 spikes, bearing together 576,840 grains. Nature

* Not counting the florets, which also are properly so many branches.

† Similar cases occur in most annuals. The forms of *Bromus mollis* and *racemosus* with simple spikelets instead of rich panicles are well known; less known and less remarkable are the depauperate specimens of *Umbelliferæ* with one single unifloral umbel, some of which of *Scandix Pecten* are in my possession. I have also specimens of *Solanum nigrum*, one and a half inch high, with a solitary terminal flower.

herself, as well as art, in various ways may effect such an independent separation of developed branches or of undeveloped buds, and this too either above or beneath the ground. Propagation of the Strawberry by its runners; of the Potato and the *Helianthus tuberosus* by their tubers; of bulbous plants by their bulbs; of the Garlic by the bulblets formed in the process of flowering, and falling off like seeds; of the varieties of the beautiful *Achimenes* by the amentaceous or the strobilaceous deciduous shootlets, are well-known examples of this process; and thousands of others might be adduced*.

The gardener can not only separate individuals, but unite them upon one stem. This is true not only of individuals of the same species, but even of those of different species; sometimes even of different genera of the same family. The Lilac is not unfrequently grafted upon the Privet (*Ligustrum*), the Pear upon the Mountain Ash (*Sorbus Aucuparia*), the Peach upon the Almond. By the insertion of a bud (inoculation), or of a developed sproutlet (grafting), we are thus enabled to pluck different kinds of roses from the same bush, to gather different kinds of fruit from the same tree. It would evidently be a contradiction in this case to consider the whole tree, or the whole bush, as the individual; for we should then give the name to a compound of several species, or even of several genera.

In attempting to comprehend the vegetable individual in its simplest form, we have thus far spoken of unessential branches only, and have endeavoured to show that they cannot be regarded as mere parts of the individual. But there is another kind of branches, those which are essentially requisite for the attainment of the end of vegetation,—for the formation of flowers and fruit. These occur in all plants which possess no terminal buds, and

* I will only adduce a few more of these examples, which might be multiplied indefinitely. Besides the Garlic (*Allium sativum*), in many other species of *Allium*, e. g. *A. oleraceum, carinatum, vineale*; *Lilium bulbiferum, tigrinum, humile*, and other species; *Gagea fistulosa, Ficaria ranunculoides, Dentaria bulbifera, Saxifraga bulbifera* and *cernua, Cicuta bulbifera, Polygonum viviparum, Begonia bulbifera, diversifolia*, and other species, *Remusatia vivipara, Cystopteris bulbifera*—buds fall off above the ground (as bulblets). In *Stratiotes aloides* rosette-like developed axillary shoots separate close to the base. The separation of lateral shoots in *Lemna* is well known; and it occurs in a similar manner in *Pistia*, by the separation of thin-stalked lateral rosettes, and in *Hydrocharis* in the separation of peculiar winter-buds. When the inferior leaf-formation is gorged with sap, bulblet-like buds form from the axils of the root-leaves (frondes fundi) in *Saxifraga granulata* and many exotic species of *Oxalis*, in the same way as the bulb-brood of monocotyledonous bulbous plants. Inferior leaf-buds which are placed on the ends of their stolons become free by the death of the runners in *Epilobium palustre, Lycopus Virginicus*, &c., and swell out and form little lumps. Cf. on this subject Wydler (Flora, 1853, p. 17–24).

which must hence necessarily have some branches in order to attain the end of their existence. This is the case with the Evening Primrose, Larkspur, *Orchideæ*, &c., whose lateral flowers are just such essential branches. If we demand that the individual should be a complete representative of the characters of the species, as is implied in the usual view, then we must add to the principal axis such branches as these,—without which the process of vegetation is not concluded, and on which, in fact, the most essential and characteristic parts of the plant make their appearance,—and call these, parts of the same individual. In this sense Schleiden's view of the simple plant might perhaps be justified, although, as he starts from different premises, he does not consider mere floral branches as particular individuals. He says, "If nothing but organs of reproduction, or flowers, spring from the bud, we still call the plant a simple one*."

Here, however, we arrive at a contradiction, which shows us that we cannot carry out the idea of the vegetable individual with the requisite definiteness in this way, since we thus regard essentially similar branches, now as individuals in themselves, now as mere parts of individuals. As I have already remarked, Schleiden allows individual importance to branches which are identical † with the main axis; those on the contrary which produce flowers alone, and in this respect differ from the main axis, he regards as mere parts of the simple individual. This distinction when analysed is perfectly nugatory; since it only lays down two extremes, between which there is an infinite number of gradations. Strictly speaking, there are no branches which are perfectly identical with the main stem, as is evident from the fact that no branch begins with cotyledons, as the main axis does ‡. Besides, the foliaceous leaves on the branch are almost always fewer than those on the main axis, and generally fewer in proportion as the point is higher where the branch originates. The arrangement of the leaves on the branches, also, often differs from the arrangement on the main axis, as *e. g.* in most of our broad-leaved trees,—in the Elm, Hazel, Chestnut, Linden, &c., in which the phyllotaxis on the main axis, and often at a later period in the so-called "water-shoots" (Wasserschossen), is spiral or decussate, while on the branches it is, on the contrary, distichous. In *Alnus viridis* the phyllotaxis is tristichous on the main axis, and distichous on the

* Grundz. ii. p. 4. † *Ibid.*

‡ The basilary cotyledons of the branches, indeed, have been compared to cotyledons. This comparison is partly justified in view of the commencement of phyllotaxis on the branch; which often resembles that on the main axis, while in regard to form and consistency almost all resemblance disappears.

branches. On the main axis of Cypresses and *Thuja* there are three- to four-leaved whorls; on the branches the pairs of leaves are nearly decussate; this is also the case in *Lysimachia vulgaris*. In the same way in *Equisetum*, the number of the rameal verticillate leaves is always inferior to that of the cauline ones. While thus on the one hand the vegetative branches are nowhere entirely similar to the stem from which they spring, on the other hand it appears that those branchlets which seem to bear flowers only are usually more numerous than they seem to be; since in most cases one, two, or even more small leaves (bractlets) are present beneath the flower, which may easily escape notice on account of their diminutive size, although their existence may be often ascertained with certainty even in those cases in which they are not visible when the flower has reached its complete development*. If we are to deny individuality to those buds (branches) only which are composed of a flower alone, as a strict

* In fact, all the constant lateral flowers of *Primulaceæ*, *Cruciferæ*, *Capparideæ*, *Resedaceæ*, *Balsamineæ*, *Orchideæ*, never have any bractlets. Among monocotyledonous plants in many cases there is only one bractlet; among the dicotyledonous there are generally two. *Gesneriaceæ* have generally three; *Empetrum* and *Santalum* have four, *Eriostemon* five; *Polemoniaceæ*, *Cuscuteæ*, and other plants with panicled inflorescence, an indeterminate number. We possess the following means of showing the existence of suppressed bractlets:—1. The position of the parts of the flower relatively to the axis of origination from which the lateral flowers spring. 2. Analogy. 3. The study of malformations. 4. Observations of the flower's development. The first criterion can be applied only where we can determine the succession of the parts of the flower. The position of the parts of a lateral flower depends, in fact, upon determinate laws of rameal origination; when they do not harmonize with these laws, we must conclude that preceding leaves have been suppressed. In this way, *e. g.*, we can explain the very common position in the 2-5th arrangement of the calyx with the second sepal posterior, by supposing two bractlets according to the fixed law, while it cannot be explained without these bractlets. Analogy aids us most by confirming our conclusions, as *e. g.* in the families *Scrophularineæ*, *Labiatæ*, &c., in which many genera present distinct bractlets, while others appear to be without them. In monstrous flowers (in cases of *antholysis* and *chlorysis*), sometimes without any other malformation, bractlets otherwise imperceptible appear in an abnormal growth. Not unfrequently in *Digitalis purpurea*, which in its normal state presents no bractlets, but in which we inferred their original existence from æstivation and the position of the calyx relatively to the axis, I have found bractlets developed in the most heterogeneous degrees, especially on the lowest flowers of the raceme of cultivated specimens. C. Schimper and myself have both observed the same fact in *Tropæolum majus*, which, like most species of this genus, presents no trace of bractlets in the normal state. We have seen them in the form of very small, white, subulate leaves, about in the middle of the flower-stalk, while the flower remained unchanged in all other respects. Their existence, however, was already indicated by the position of the quincuncial calyx relatively to the axis, as well as confirmed by analogy, for *Tropæolum ciliatum*, R. et P. (Pöpp. et Endl. Nov. Gen. t. 38), in its normal development has two round and

interpretation of Schleiden's language demands, we should have to draw a most unnatural and often impracticable line of demarcation between branches which, physiologically speaking, are perfectly homologous (floral branchlets which really have no bracts), and those which bear imperceptible or even suppressed (abortive) bracts. If, on the other hand, we would reckon the latter also among the branches which are not individuals, then it may be contended that there is such a series of gradations in regard to number and vigour in the leaves which precede the rameal flower, that it is impossible to draw a dividing line even in this manner.

The above-mentioned distinction between unessential and essential branches seems to afford a better stopping-place, no matter whether the branch bears nothing but a flower or not. We might say, all essential branches must be regarded as individuals since they repeat the process of specific development laterally, and can become independent plants, as layers, whether natural or artificial. Those branches, on the contrary, which appear as necessary members in the line of development which is advancing towards flower and fruit, and which therefore complete the series of formations belonging to the species, and without which the plant is either unable to eke out its vegetable life or to accomplish propagation, must be regarded as members of one and the same history of development. Let us take a case where the main stem bears only proper leaves, branches of the first order only bracts, and those of the second order only flowers and fruit, as is really the case in *Plantago, Melilotus, Veronica officinalis* and *Chamædrys*; here it is evident that these three divisions cannot be isolated; that all three must necessarily be present in order that the specific life may attain a complete representation in one individual*.

Notwithstanding the importance of this discrimination be-

prettily ciliated bractlets on the flower-stalk. I have mentioned the history of development last, not to disparage study, but because the morphology must be rightly understood beforehand by means of comparisons of developed structures, and because in its present stage the development is incapable of giving us reliable information in regard to all the leaves which are present in the germ, though they may not develope. To know what parts then exist, we should have to be able to distinguish the leaf as a cell or a group of cells before it rises to view above the surface of the stem.

* [But why assume (as here and *supra*) that the species must attain a complete representation in a single individual in vegetables?—since this is by no means the case in the higher (unisexual) animals, where there is no doubt as to what corporeally constitutes the individual,—that is, in the very cases whence we derive our idea of individuality, and the standard of comparison which our author is endeavouring to apply to the case of plants.—Asa Gray.]

tween essential and unessential branches, it cannot, when analysed, establish a distinction which will enable us to decide upon their importance as individuals; for even those branches which appear unessential, in relation to the formation of flowers and fruit, may yet be essential to the plant in other relations: as when they appear as characteristic elements of the vegetable structure, or when they play any important part in the œconomy of the plant, as I have shown *in extenso* elsewhere*. Nay, more; one and the same branch, as to whose nature there seems to be no doubt, may appear either as essential or as unessential, according to circumstances. When those branches which conduct the structure to a higher stage of its development appear in great numbers, on a principal axis, as *e. g.* in indefinite racemose or spicate inflorescence, the lateral branchlets appearing as flowers are then indeed, generally speaking, necessary to the plant's full completion of the series of formations, and in this sense essential; but their number is immaterial as regards this completion; and this the plant itself shows in producing either a larger or a smaller number of them; sometimes the number is reduced to one†. Therefore, properly speaking, only *one* lateral flower is essential; and we may arbitrarily consider any one of the number to be this essential one. Hence each of them may be regarded indifferently as essential or unessential. This is not the case in those racemes and spikes which possess a terminal flower, as is the case in many *Campanulaceæ, e. g.* in *Campanula rapunculoides*. Here, all the lateral flowers are unessential; yet if the terminal flower is cut off, the lateral branchlets which bear the flowers at once become essential. Such a change is not always artificial, for it often happens naturally, as there are plants in which the terminal flower may be either present or absent. *Agrimonia Eupatoria* and *Campanula rapunculoides* are examples of this variability‡.

* Verjüngung, p. 41 *et seq.*

† *E. g.* not unfrequently in the raceme of *Lathyrus odoratus.*

‡ *Agrimonia Eupatoria* bears usually one spike without any terminal flower; in weak specimens, a terminal flower not unfrequently makes its appearance, which opens before the upper lateral flowers. This has been observed by Wydler (Bot. Zeit. 1844, p. 642). In *Campanula rapunculoides* the case is just the contrary: its looser spikes are usually terminated with a flower, while denser ones end in a coma of bracteal leaves, without any terminal flower. *Dictamnus* resembles *Agrimonia*; while *Triglochin* (especially *Tr. maritimum*) on the other hand imitates *Campanula*. Even in plants in which the essentiality of the lateral position of the flower is expressed by their zygomorphic development, terminal flowers make their appearance in some cases; they then resemble *Peloriæ*. This is the case in *Linaria, Orobanche*, and a *Digitalis purpurea monstrosa* (described by Vrolik, Flora, 1844, No. 1), which propagates by seeds, and is now widely disseminated in our gardens.

We can cut this Gordian knot only by deciding to consider every branch as an individual, however appearances may be against it, provided that we have other grounds sufficient to regard branches as individuals. The genesis of branches justifies us in so doing; for each branch is not a direct continuation laterally, is not a development belonging to the stem (like the leaf), but is a new formation; like the main axis itself, it has its own centre of formation, with its peculiar development. Branch and stem, main axis and lateral axis, differ therefore only in their origin and relative position; but they are essentially of the same nature; they are united in the idea of the *shoot*. The stem is the primary and principal shoot of the whole plant; the branch is a lateral shoot in reference to the main shoot; but it can itself become a relatively main shoot, and the stem of a succeeding generation of shoots in its turn. As far, then, as we are justified in speaking of vegetable individuality at all, we must hold fast to the individuality of the shoot: *the shoot is the morphological vegetable individual*—is that form or that part of its specific realization which is analogous to the animal individual, if any part is.

In zoology we give the name of individual to every whole which is controlled and bound together from one vital centre. Since such an internal domination of the organism as that which characterises animal life is wanting in plants, whose existence is a process of growth directed externally alone, we can only demand, as the criterion of vegetable individuality, that the individual shall be formed in direct continued development from one centre, and thus, in accordance with its origin, *shall, in all its parts, belong to one centre.* Now this is the character of the shoot. Its centre of formation has been known since C. F. Wolff's celebrated "Theoria Generationis" (1759) under the name of "*punctum vegetationis*;" it is what is called in common life the "heart" of the plant, or, at the first appearance of the lateral shoot, the "eye." The whole future of the plant slumbers unseen within it; leaf after leaf arises out of it, step by step, at a measured pace, prescribed by law, until (in case the shoot is destined to conduct the development thus far) the series concludes with the last formation, that of the carpels, which close over the dying point of vegetation and form the fruit. In this progress the centre, always keeping the lead, is ever advancing, rising more and more, and leaving behind it an axis arrayed with the organs already formed. Hence we may designate the vegetable individual as *the sum of the parts belonging to one axis.* Just as the body of the animal has only one trunk and one head, the shoot has but one axis and one apex. As the trunk of the animal has a second extremity opposite to the terminating head, and gradually dwindling down till it forms the tail, so the perfect shoot has a second extremity opposite to that which terminates with the most perfect structure (the fruit), and dwindling down to an indeterminate end, the root, by means of a *punctum vegetationis* turned downward*.

But it will be objected: is not the vegetable shoot indefinitely divisible; can we not cut it up into an arbitrary number of pieces, each of which is capable of reproducing the whole plant in its turn? Were this the case, the phænomenon would not be without its parallel among the lower animals. But this is not the case. The supposed divisibility of the vegetable shoot, at least in perfect plants (the Phanerogamia), to which I am now alluding, is a delusion, which rests simply upon the fact that the formation of new shoots has been confounded with a reproduction of the shoot as such. As the injured shoot has the faculty of producing new shoots, so the parts of the divided shoot have also this faculty in many cases; but this is no recompletion of the shoot itself; the fragment of the old shoot can continue to develope in one single case only—when, in fact, it bears the apex of the axis with the point of vegetation. Let us examine this case more closely. If a shoot is divided transversely, under certain circumstances the upper part, on which the *punctum vegetationis* ("the heart") is still remaining, may continue the development; but the lower part is nothing but a stump, and continues to be a stump which can never complete itself by a terminal shoot, and which never fails to die if it is not nourished by lateral sprouts formed before, or sometimes after, the division took place, and thus kept alive by its posterity. This cannot be called divisibility, in the usual meaning of the term; the whole phænomenon, on the contrary, strongly reminds us of the capacity animals possess of losing the less essential caudal extremity

* Aristotle, on the contrary, considered that the root, being the imbibing organ, was the part of the plant which corresponds to the upper part, to the head and mouth of the animal; and he regarded the stem as the inferior part. He found the cause of this topsy-turvy position of plants in the necessity under which they labour of drawing their nourishment from the earth, as they are incapable of moving from place to place. In this respect he compares plants to mussels (ὀστρακόδερμα), which also have their heads turned downwards. Cf. Wimmer, Phyt. Arist. Frag. 56–65. This comparison of the root with the animal's head is however, morphologically speaking, inverted; for as the highest stratum of the spinal cord (the sensorial portion) attains its maximum state of development in the head of animals, it can only be compared to that extremity of the plant's axis in which the highest and noblest part of the plant is exhibited. Besides, the peculiar and striking characteristic of the animal's head, its involved structure terminating the organism, is by no means to be found in the root end of the plant; but it is seen in the opposite end which terminates with flower and fruit.

without any cessation of life. In favour of this view the fact may be adduced, that a similar phænomenon occurs in the normal process of development of plants and animals. As there are animals which may spontaneously lose the posterior extremity of their body during the course of their development, as *e. g. Cercaria, Comatula,* Frogs, &c., so there are also numerous plants in which the posterior extremity gradually dies off, and is cast aside, during the course of growth, while the anterior end of the shoot, which bears the *punctum vegetationis,* continues to unfold; as is seen in the growth of many Mosses, especially of Peat-mosses; in the creeping and climbing root-stocks of Ferns and *Aroideæ*; in the long creeping stems of *Lysimachia nummularia*; the little subterranean creeping root-stocks of *Paris*; in most plants which possess a *radix præmorsa,* as *e. g. Succisa pratensis,* the perennial species of *Plantago,* in *Tormentilla,* &c., with which the perennial bulbs of Monocotyledonous plants agree in all essential respects; and finally, this is especially remarkable in *Utricularia* and in *Selaginella increscentifolia,* whose apices only form close buds, and last through the winter, while all the remaining parts of the shoots perish. If the shoot is indivisible transversely, it is still less so longitudinally. There is not a single case to prove that a shoot longitudinally divided can as such continue to develope; nor do we know of a single case where such a longitudinal division takes place spontaneously. What has been usually described as a bifurcation of the stalk depends in the Phanerogamia in every case upon a true ramification which takes its rise laterally close under the apex, as I have have already described it in the case of *Erythræa pulchella.* As a *normal* formation no immediate division of the stalk occurs among Phanerogamia; for the phænomenon known as "fasciation," which might be adduced here, is always a monstrosity*.

* Fasciation depends upon a real division of the *punctum vegetationis* into two parts of equal importance; in the simplest case it produces a simple division into two parts. Here neither of the two parts can be regarded as a branch of the other. If repeated bifurcations follow each other in the same plane and in unbroken connexion, the well-known "ribbon and fan"-like forms arise, which however usually end at last in single apices. Very rarely more than two parts lying in different planes are produced by the division of the *punctum vegetationis,* a case which I have noticed in the capitula of *Compositæ.* The rarest phænomenon which bears upon our subject is the annular fasciation, in which an annular border arises from the simple point of vegetation, of which I shall speak more at large in the following Part, when I compare the relations of growth in the Cryptogamia. A division of the individual corresponding to fasciation in phanerogams, and to dichotomy, its homologue, in many cryptogams, also occurs in the animal kingdom, as appears especially in many genera of corals, *e. g. Caryophyllia,* whose stocks are formed in this manner exclusively, and in *Astræa* and *Favia,* in which it appears in conjunction with

The stalk, or axis of the shoot, is hence indivisible in the higher plants, in the same sense that the body of the higher animals is indivisible*. The only phænomenon which might be described as a division of the stalk is leaf-formation. This, however, is not a division into new stalks, but a formation of subordinate parts belonging essentially to the stalk, as it were an eradiation of the stalk itself, which may be aptly compared to the formation of the extremities in the animal body. We may therefore justly describe the shoot, or the vegetable individual, as an indivisible axis,—as an axis with its appurtenant radii which are inseparable from, and regularly arranged by, its own development. With the first appearance of the branch a new axis is formed, and a new system of subordinate radii appears. However completely the branch may contrive to interweave itself with the trunk during the course of its development, it always owes its origin to an accessory point of vegetation which developes into a particular axis. The vegetable individual thus presents in its nature a certain analogy to the mineral individual,—the crystal,—as well as to the animal individual; for the crystal is determined by the relation of its parts to one and the same system of axes. As soon as this system of axes holds another position there results another individual, which may be distinguished even when two or more individual crystals intersect, so as to form twin crystals, or stellate crystals.

In the preceding considerations on the indivisibility of the axis, I described the leaves as its radiations,—as members of the stalk, and belonging essentially to it,—and I attempted to distinguish the leaves from the branches, by considering the latter as new axes. But how are leaves and branches distinguished in their genesis? Are not the branches as much radiations or lateral members of the stalk as the leaves? It would lead me too far from my subject to make a fundamental critical investigation into this question, and to examine the existing views of the mode of formation of leaves and branches, especially as investigations into this subject have not been complete enough to enable us to obtain reliable results. I can therefore only allow myself a few hints in this place. The leaf originates in the earliest period of

shoot-formation (gemmation), as was shown by Ehrenberg (Beiträge, &c., Abh. der Akad. 1832, p. 242). Ehrenberg explains the form of *Dædalinæ* as a result of incomplete termination of the individuals in gemmation; in appearance it resembles the cockscomb-like forms of fasciation as they occur in a remarkable way in some monstrous *Cacti* of the genera *Mammillaria* and *Echinocactus*, as well as in *Celosia cristata*, well known as an ornamental plant.

* [Some criticisms upon this may be given at the close of the whole memoir.—A. G.]

the formation of the stalk; and its rudiment is contemporaneous with the first stages of the formation of tissue in the *punctum vegetationis*. A leaf can never be formed at a later period from the developed axis. It is a necessary consequence of the manner in which the leaf originates, that an absolute dividing line cannot be drawn between leaf and axis; for the subsequent position of the leaves upon the organism affords no standard of appreciation, especially as most of them do not mark the basis of the leaf, which loses itself in the axis. Earlier, before the extension of the axis begins, the rudiments of the leaves are always closely pressed together, so that they appear as a peripherical development of the axis itself, occupying the whole upper surface, and dividing it into clearly defined planes, which may be recognized even in the developed state, in those plants whose foliaceous *pulvini* are distinctly marked, as *e. g.* in many Ferns, most acerose plants, in *Cacti*, and particularly in *Nymphæa* and *Victoria*, where the *pulvini* may be distinguished even in the interior of the axis. The primitive vascular system of the axis enters directly into the leaves, and ramifies there; while the woody layers of the stem, which are found later, have no connexion with the leaves. With branches the case is totally different. In their origin and development they always succeed the leaves; and even at a much later period, when the leaves have been long cast off, shoots may originate in places where, at an earlier period, no trace of a rameal rudiment, or of an eye, was to be found. If we now consider the axillary shoots,—*i. e.* those branches whose position is predetermined by the situation of the leaves,—at an early period we shall find their rudiments, even though they develope very late or not at all, in the form of a circular and slightly prominent gibbosity, which may be compared with the apex of the axis; or rather, it is an accessory *punctum vegetationis* forming near the apex. The circumstance of the epidermis of the axillary shoot being a continuation of that of the stem, is explained by the early date at which it originates; for this takes place at a time when the surface of the axis has not yet lost its flexibility. The eye is shown to be an independent centre of vegetation by its subsequent internal and external conformation; for it not only developes leaves upon its surface, and this too with an independent commencement of its phyllotaxis, but even in its interior the first system of vascular fibres seems to be formed independently of that of the main axis; as originally it lies upon it, and afterwards becomes intimately blended with it by later layers of tissue. Notwithstanding the intimacy with which later formations of woody tissue unite branch and stem, still, according to Unger's investigations, no immediate influence is exerted by the branch upon the conformation of the stem, since the stem owes none of its essential parts to the branches*. This independence of the branches is shown still more decisively in adventitious shoots, whose position is not predetermined by the leaves. Originating at a later period, they take their rise, not from the surface but from the cambium layer,—the internal tissue which preserves the faculty of producing new growths. Hence, if they would come to the light of day they must break through the bark. Their origin has been particularly described by Trécul†. W. Hofmeister, however, as I have already remarked, succeeded in tracing it in *Equisetum* back to the first cell, a cell in the interior of the stem. As is the case with axillary buds, such adventitious buds sometimes remain undeveloped for a long time (ten years and more) without losing their vital activity; a fact to which attention has lately been called by C. Schimper‡, in a Report on Exostoses. When this is the case they not unfrequently develope into spherical or conical wood-kernels, which continue to exist without any connexion with the ligneous body of the maternal stem; this is especially the case in Beeches and Poplars.

The individual nature of the shoot is confirmed not only by the mode, but by the place of its origin. While the organs of the individual organism—the leaves of the plant—occupy a position determined with geometrical accuracy, shoots, on the contrary, can arise out of almost any part of the plant,—wherever indeed any cambium exists; and they may be even enticed by art, out of places where they do not usually appear. There are shoots from the *stem*, the *root*, and the *leaves*. In herbaceous stems they appear in situations determined by the leaves (in the axils of the leaves), while they may be found anywhere on old woody stems§ as adventitious buds, or on any part of the lignified roots of most dicotyledonous woody growths, and even on some monocotyledonous ones, as in *Umbraculiferæ*‖. Shoots appear less frequently on the roots of herbaceous plants¶. Shoot-formation from leaves has often been discussed and described in

* Unger, Ueber den Bau des Dicotyledonen-Stammes (1840), pp. 65, 66.

† Recherches sur l'orig. des bourg. adv. Ann. des Sc. Nat. viii. (1847) p. 268.

‡ In Sept. 1852, in the Versammlung der Naturforscher in Wiesbaden.

§ Rarely scattered shoots appear on the herbaceous stem, and especially on the first internode under the cotyledons, as Roeper (Enum. Euphorb. 1824) first showed in *Euphorbia*, and Bernhardi in the germ of *Linariæ*. A specimen of *Begonia manicata dipetala*, cultivated in our [Berlin] Botanical Garden, which is probably the same species as the *B. phyllomaniaca* of Martius, presents the case of a plant which produces a multitude of shootlets in the whole leaf-region; they arise from the sappy stem which is not yet hardened, soon after the fall of the leaves.

‖ According to Rheede, *Corypha umbraculifera* sends forth root-shoots when the stem dies off, after the fruit has ripened.

¶ I have often observed them in *Linaria vulgaris, Helichrysum arenarium,* regard to many plants, especially *Bryophyllum, Cardamine pratensis, Drosera, Malaxis paludosa,* &c. A fine example of this is shown by a *Chelidonium majus var. laciniatum* reared by Bernhardi in the Botanical Garden at Erfurt, from whose leaves floral bractlets arose, partly unifloral, partly multifloral, without any preceding leaves*. Shoots may be allured by the gardener out of most leaves which do not wither too soon†. Finally, the little budlets in whose bosom the germ of the new plant is formed and developed, and which we call seeds, are a kind of shoots, which in most cases owe their origin to leaves (carpels), out of which they spring (on the margins, which unite to form the placenta), or more rarely, out of their whole inner surface.

[To be continued.]

BIBLIOGRAPHICAL NOTICES.

Glaucus; or the Wonders of the Shore. By Charles Kingsley. Cambridge: M'Millan. 1855. 12mo.

The relief of the hapless individuals who feel themselves compelled to pass a certain number of weeks every summer out of town, without knowing in the least what to do with their time when away from their accustomed haunts, is the object which Mr. Kingsley has proposed to himself in the publication of this little book, which in our opinion is one of the most charming amongst the many admirable popular works on Natural History that have appeared of late. It may be defined, and we trust that the Reverend author will not be offended at the expression, as a Sermon on the Advantages of the Study of Natural History, but written in such a style and adorned with such a variety of illustration, that we question whether the most unconcerned reader can peruse it without deriving both pleasure and profit from his labour.

At the outset, as was to be expected, our author expatiates upon the great superiority of the study of Natural History over all the other sources to which mankind generally resort for their amusement, and here we think he has been betrayed by his zeal into a slight indiscretion; not that he has placed his favourite studies upon too high a pedestal, but he has treated those from which he wishes to wean his readers with too little consideration. In Mr. Kingsley's

Rumex Acetosella, Ajuga Genevensis, Jurinea Pollichii, Nasturtium sylvestre et *pyrenaicum.* According to Wydler, they often appear in *Viola sylvatica.*

* I may add to the examples I have given of shoot-formation taking place out of the leaves, one which I observed in June 1853, in *Levisticum officinale.* I found, in fact, in several species of this Umbellifer, one or more, frequently two, shoots in the points of division of the leaves, which after producing a few weak leaves bore a small umbel.

† Kirschleger (Flora, 1841, No. 2) notices a fine example of this in *Gloxinia speciosa.*